are found at Warsaw occasional monthly maxima that are diminished relative to the means these months are rather scattered. This character is frequent during the winter months when clear days are rare at Warsaw and changes in max. Q (large departures negative or positive) become very considerable, but they are of local character.

But if it is necessary to be extremely careful relative to lowered values in winter we can not pass without examination of depressions of even short duration observed in summer when, in general, the number of clear days is large enough and the conditions are favorable enough for actinometric measurements. After the last marked depression of 1912 the years following have been rather normal relative to annual means, as appears from an examination of Table 1.

However, there is noted the depression in the summer of 1916 with the following departures (in hundredths of a gr. cal., calculated at the Central Meteorological Institute of Poland by E. Stenz):

June	− 3	September	2
July	− 6	October	−6
August	−13	November	−6

At first we were disposed to believe that here there was a matter of a rather local depression observed at Warsaw, although the days with sun not veiled were numerous enough and the sky appeared sufficiently pure. But the fact that the same depression was observed simultaneously at Florence and at Izana (Canary Islands) leads to the conclusion that here there is a matter of a phenomenon of more general character.

Let us note that the measurements at Florence are made with the Ångström pyrheliometer; the measurements at Izana (lat. 28° 15′ N., long. 16° 57′ W., elevation 2,100 meters) made with the Abbot actinometer (silver disk N. 25) have been published under the direction of the Central Meteorological Institute at Madrid.

The depression of the summer of 1916 was followed by atmospheric disturbances relative to optics and polarimetry, as has been demonstrated especially by Dorno at Davos (Switzerland). The cause of this depression has not been discovered; it is only admitted that it was not of volcanic origin. Let us add that this coincidence of depressions in the values of solar radiation and in the values of polarization does not always manifest itself; it occasionally happens that the diminution in the polarization of the sky is observed, although the values of intensity of solar radiation do not show parallel changes.

In closing this paper, let the attention of observers be called to the theoretical and practical interest of continuous measurements of the intensity of solar radiation made with tested apparatus.

PROLONGED PLANT ACTIVITY AT GRAND HAVEN, MICH., IN AUTUMN OF 1920.

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By H. TULLSON, Meteorologist.

[Weather Bureau, Grand Haven, Mich., Dec. 20, 1920.]

Early in November of 1920 it was observed by many persons and commented upon in the newspapers that various wild plants were blooming later than usual in this vicinity. Up to November 10 no severe frosts had occurred, and there had been but three days with mean temperature below that generally necessary for plant growth, two of these having occurred late in October and one in November. As a consequence, the foliage of practically all the herbs, shrubs, and trees was still green. Though in previous years no systematic record with which to make comparisons had been kept, it was decided, early in November, to make notes during the rest of the season on the late blooming of wild plants [1] and the persistence of verdure. Accordingly, a suitable area was selected, and the vegetation thereon noted at intervals as long as growth continued. This tract is owned by Dr. Edward Hofma and embraces about 8 acres of lowland flats inclosed together with some marsh land by Grand River and one of its "ox bows." The ground selected is composed of quite firm soil, upon which flourish not only herbs but shrubs and small trees also. The characteristic vegetation of the adjacent marsh is cat-tail, reed, and wild rice.

A cold spell, with mean temperature somewhat below freezing, extended from November 11 to November 16, inclusive; but during this time a blanket of snow covered the ground, affording protection for the abundant herbage. The snow came in advance of the coldest weather; otherwise it is clear that the activity of practically all the vegetation would have been brought to a close in the second week of November. As it was, the leaves of the trees and shrubs—chokecherry, white dogwood, poplar, willow, etc.—were frozen at this time.

Beginning November 17 there was a period of warmer weather and the snow disappeared rapidly, while growing temperatures prevailed from the 18th to the 21st. On Thanksgiving Day, November 25, 20 species of wild plants were observed in bloom, which may safely be called an unusual number despite the fact that no previous records for comparison exist. These plants were the following: Dandelion, mallow, yarrow, white sweet clover, silvery cinquefoil (on adjacent uplands), common chickweed, peppergrass, blind gentian, common evening primrose, red clover, bouncing Bet, goldenrod (*Solidago altissima*), wild strawberry, white campion, beggar ticks (Bidens sp.), daisy fleabane (*Erigeron annuus*), common ragweed (bearing male and female flowers), smartweed (*Polygonum persicaria*), lamb's-quarters, and pansy (escaped from cultivation). Of these the first eight were more or less numerous, while only one or a few individual plants or clumps of the others were observed in bloom. A red raspberry bush bearing ripe and well-formed fruit was found. All the yarrows and evening primroses seen in bloom on this day were plants that had been bent over by the weight of the snow of mid-November and thus protected; and now also were partially sheltered by long, dried grass.

Though from the 25th to the 30th there was but little freezing weather, the mean temperature of only one day was as high as 42°, and there was but little sunshine. The ground was bare, but not frozen. No more evening primroses, bouncing Bets, goldenrods, silvery cinquefoils, beggar ticks, daisy fleabane, or lamb's-quarters were observed in flower after the 25th. On the 30th, however, the rest of the Thanksgiving Day list, as well as one plant of shepherd's purse, doubtless overlooked before, were still in bloom.

On December 5, 1920, a day with mean temperature 40°, from one to a few blooming plants of the following

[1] Acknowledgments are due H. T. Darlington, assistant professor of botany, Michigan Agricultural College, for determining certain plants the specific identity of which was in question.

were observed: Peppergrass, red clover, pansy, yarrow, common ragweed, smartweed, dandelion, and white sweet clover. Chickweed also was common, but scarcely deserves mention, as it is not only one of our hardiest plants, but also one of our few wild everbloomers. Although there occurred days in the first half of December with mean temperature freezing or below, this month brought no severe cold until after the 15th, on which date, however, a snow cover arrived. Thereafter, to the end of the month, from one-half inch to more than 4 inches of snow lay on the ground. Protection from cold, however, no longer served to postpone the time for cessation of blooming. Besides, the pressure of the snow for so long doubtless was not without its ill effects. Consequently, on January 1, 1921, but two species besides the ubiquitous chickweed were found in blossom, namely, dandelion—one head partly open—and peppergrass. The snow cover disappeared on this date, and fresh-appearing foliage—abundant in many instances—of the following plants was noted: Yarrow, dock (Rumex sp.), dandelion, white clover, sweet clover, red clover, evening primrose, narrow-leaved plantain, bouncing Bet, motherwort, hollyhock, chickweed, goldenrod, nettle, mullein, common ragweed, peppergrass, cinquefoil (undetermined species), tall crowfoot, common plantain, and several others.

From January 1 to January 11, 1921, the ground was bare, temperature fell to freezing or below almost every night. The result was that when the tract was next visited, about the middle of the month, only in sheltered spots was any green vegetation to be found.

Notes made in the autumn of 1921 show that while November of that year was almost as mild as November of 1920, a very thick deposit of frost on the 2d, minimum temperature 30°, had a decidedly prejudicial effect upon the vegetation of the tract. Nine species were still in bloom on the 6th, but there was a rapid decline in floral and vegetal activities thereafter. On November 25 a few sickly blossoms of four species were found. These were mallow, yarrow, dandelion, and peppergrass. The state of the foliage of all species was also quite in contrast to that noted on the same date of the previous year. Now, green leaves could be discerned only in unexposed places, whereas in the last week of November, 1920, vegetation was actually flourishing.

Temperature and the snow cover were practically the only meteorological factors considered in these studies. Questions as to flowering and fruiting as controlled by length of day were not taken up. In this connection, however, it is interesting to note the status of asters and goldenrods, which are usually thought of as the very latest of fall flowers. No asters were found in bloom upon the area on the date the study was begun, or thereafter; and goldenrod flowers had ceased to be abundant at that time. Another circumstance bearing on growth as related to length of day is that some ragweeds found on November 25, 1920, were stunted, but bore an abundance of both staminate and pistillate flowers. This ragweed is an annual, and the seeds from which these late plants sprang doubtless had been dropped shortly before and, meeting the proper conditions for germination and growth, had begun to develop. It has been pointed out (see Garner and Allard, Yearbook, Department of Agriculture, 1920) that "late planting * * * may lead to dwarfing in growth but abundant flowering and fruiting."

To return from this digression, and to sum up:

The prolonged activities of wild plants in November, 1920, in the vicinity of Grand Haven, Mich., were due not so much to the mildness of the autumn as to the fact that a snow cover protected vegetation during periods in which the temperature was low enough to destroy exposed plant life.

TEMPERATURE AND THE BLOOMING OF CHERRY TREES.

S. Aoki and Y. Tazika, meteorologists in the Central Meteorological Observatory in Tokio, Japan, have an interesting article in the *Journal of the Meteorological Society of Japan*, April, 1921, on the correlation between the air temperature and the date of blooming of certain cherry trees located in the Observatory grounds.

The period covered by the records is from 1900 to 1921. The average date of blooming is April 2, while the date varied from March 25 in 1913 and 1920 to April 8 in 1917.

The correlation between the mean temperature for 30 days from February 16, and the date of blossoming, gives a coefficient of -0.94, with a probable error of only ± 0.015.

The correlation between the mean temperature for 20 days from February 16 and the date of blossoming, gives a coefficient of -0.80 ± 0.054.

The ability to determine the probable date of blossoming of cherries or other fruit from 10 to 15 days in advance would be of considerable value in making preparation for spraying. The experience in Japan indicates that this will be possible wherever the records of temperature and blossoming dates are long enough to furnish data for calculating the necessary mathematical equations.—*J. W. S.*

RELATION OF TEMPERATURE TO CITRUS SCAB.

The result of some interesting experiments by Prof. H. S. Fawcett in connection with the relation of temperature to infection and growth of the citrus scab fungus is given in the *Journal of Agriculture Research*, May 16, 1921, Vol. XXI, No. 4. In some previous work it was found that abundant moisture was present when bad infection took place, but seasons were encountered when scarcely any infection occurred when moisture and growth appeared to be ideal for an outbreak. Consequently these later experiments were prosecuted to determine what influence the temperature might have.

The tests were made in greenhouse experiments on sour-orange seedlings, with artificially inocculated plants, at temperatures varying from 12° to 42.5° C.

The inocculation temperatures that resulted in infection of growing plants under conditions of rapid growth and abundant moisture were 16°, 18.5°, 19°, 20°, 21° and 23° C. No infection was obtained under the same conditions at temperatures under 16° and above 23° C. Detached leaves floated in water with the scab fungus were infected at 16°, 18.5°, 21°, 24.5°, and 27.5° C.

This limited range of temperature at which infection of a susceptible host took place under the presumably favorable conditions of the experiment appears to explain the great difference observed in the occurrence and serverity of scab from year to year; it also apparently explains the difference of previous inocculation experiments not hitherto understood.

The conditions necessary for scab infection indicated by these experiments are (1) viable spores of the fungus, (2) young citrus leaves of a susceptible species, (3) moisture, and (4) temperatures between 16° and 23° C.—*J. B. K.*